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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/976,624	10/12/2001	Werner Juengling	MI22-1789	2304

21567 7590 05/14/2002

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EXAMINER

KIELIN, ERIK J

ART UNIT	PAPER NUMBER
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2813

#4

DATE MAILED: 05/14/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/976,624

Applicant(s)

JUENGLING ET AL.

Examiner

Erik Kielin

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 12 October 2001.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 97-114 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 97-99 and 102-114 is/are rejected.
- 7) ☒ Claim(s) 100 and 101 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 12 October 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 2. 6) ☐ Other: _____

DETAILED ACTION

Information Disclosure Statement

The information disclosure statement filed 8/6/01 fails to comply with the provisions of 37 CFR 1.97, 1.98 and MPEP § 609 because the some of the references have not been provided with dates in accordance with 37 CFR 1.98(b)(5). Also the MPEP 609 states,

“Each publication must be identified by publisher, author (if any), title, relevant pages of the publication, and **date** and place of publication. The date of publication supplied must include at least the **month and year** of publication, except that **the year of publication (without the month) will be accepted if the applicant points out in the information disclosure statement that the year of publication is sufficiently earlier than the effective U.S. filing date and any foreign priority date so that the particular month of publication is not in issue.**” (Emphasis added.)

The IDS has been placed in the application file, but only the references initialed by Examiner have been considered. Applicant is advised that the date of any re-submission of any item of information contained in this information disclosure statement or the submission of any missing element(s) will be the date of submission for purposes of determining compliance with the requirements based on the time of filing the statement, including all certification requirements for statements under 37 CFR 1.97(e). See MPEP § 609 ¶ C(1).

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

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(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in-

(1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effect under this subsection of a national application published under section 122(b) only if the international application designating the United States was published under Article 21(2)(a) of such treaty in the English language; or

(2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that a patent shall not be deemed filed in the United States for the purposes of this subsection based on the filing of an international application filed under the treaty defined in section 351(a).

1. Claims 97-99, 103, and 104 are rejected under 35 U.S.C. 102(e) as being anticipated by US 5,723,368 (**Cho et al.**).

Regarding claim 97, **Cho** discloses a method of forming a material adjacent a conductive electrical component comprising:

providing the conductive electrical component **24** over a substrate **22** (Fig. 1A; col. 4, lines 30-36);

spinning a liquid **26** onto the substrate **22** and adjacent the conductive electrical component **24** (Fig. 1B; col. 4, lines 40-43);

at least partially curing the liquid into a substantially self-supporting mass wherein it becomes a self-supporting mass, called a "gel" (col. 4, lines 53-61);

partially vaporizing the mass to form a porous dielectric layer (col. 5, lines 27-33), wherein the vaporizable portion is a solvent and the non-vaporizable is the dielectric **28** that remains behind, as further limited by instant claims 98 and 99; and

forming a layer of an insulative material **30** overlying the partially vaporized mass (Fig. 1D; col. 5, lines 33-40), as further limited by instant claim 103.

Regarding claim 104, the mass comprises silicon (Si) and carbon (C) because it is formed from TEOS, (tetraethylorthosilicate, tetraethoxysilane, $\text{Si}(\text{OCH}_2\text{CH}_3)_4$). (See col. 4, lines 42-49.)

2. Claims 97-99, 102, and 104 are rejected under 35 U.S.C. 102(b) as being anticipated by US 5,494,858 (**Gnade** et al.).

Regarding claim 97, **Gnade** discloses a method of forming a material adjacent a conductive electrical component comprising:

providing the conductive electrical component **24** over a substrate **22** (Fig. 1A; col. 4, lines 30-36);

spinning a liquid **25** onto the substrate **22** and adjacent the conductive electrical component **24** (Fig. 1B; col. 4, lines 43-49);

at least partially curing the liquid into a substantially self-supporting mass wherein it becomes a self-supporting mass, called a “gel” (col. 4, lines 64-67);

forming a layer of an insulative material **26** overlying the mass **before** vaporizing the mass (Fig. 1D; col. 5, lines 33-40), as further limited by instant claim 102; and

partially vaporizing the mass **25** to form a porous dielectric layer **28** (col. 5, lines 13-20), wherein the vaporizable portion is a solvent and the non-vaporizable is the dielectric **28** that remains behind, as further limited by instant claims 98 and 99.

Regarding claim 104, the mass comprises silicon (Si) and carbon (C) because it is formed from TEOS, (tetraethylorthosilicate, tetraethoxysilane, $\text{Si}(\text{OCH}_2\text{CH}_3)_4$). (See col. 4, lines 51-56.)

3. Claims 105-107, 112 and 113 are rejected under 35 U.S.C. 102(e) as being anticipated by **Rostoker** et al. (US 5,744,399).

Regarding claims 105 and 106, **Rostoker** discloses a method of forming a material adjacent a conductive electrical component or between a pair of components comprising:

providing the conductive electrical component **10** over a substrate **7** (col. 1, lines 28-30; col. 3, lines 6-12);

providing a mass **20** (Fig. 2) having pores of a size (Fig. 1A; col. 2, lines 54-59) adjacent the conductive component **10**, wherein the mass has a matrix forming material comprising **silicon** (SiO_2 ; col. 3, line 38-42) with fullerene (porous **carbon** molecules containing 32 to 960 carbon atoms; col. 3, lines 46-52) dispersed throughout, and where the mass is applied by spinning on the matrix material with the fullerene dispersed therein (paragraph bridging cols. 4-5); and

vaporizing the portion into a mass **24** (Fig. 4, col. 6, lines 41-47), wherein the vaporizing expands the size of the pores (Figs. 1B-1D; col. 2, line 62 to col. 3, line 5), wherein the vaporizing is carried out using oxygen plasma or ozone (column 7, lines 20-49); and

forming a layer of an insulative material **40** overlying the mass, after the vaporization step (column 6, lines 10-20, 40-45), as further limited by instant claim 112.

Regarding claim 107, **Rostoker**, discloses an example ("EXAMPLE 1" at col. 10) having 90 wt% SiO_2 and 8 wt% C_{60} . On a basis of 98 grams, then there is $90 \text{ g } \text{SiO}_2 / (64 \text{ g/mol } \text{SiO}_2) = 1.4 \text{ mol } \text{SiO}_2$ and therefore 1.4 mol of Si. Similarly, there is $8 \text{ g } \text{C} / (12 \text{ g/mol } \text{C}) = 0.67 \text{ mol } \text{C}$. Accordingly the ratio is 1.4 Si: 0.67 C or about a 2:1 ratio of Si to C. which falls with the claimed range of 5:1 to 1:3. (See also col. 5, lines 25-39.)

Regarding claim 113 (which depends from claim 107), a pair of metal lines **94** (Fig. 6) with the porous mass provided there between.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claims 108-111, are rejected under 35 U.S.C. 103(a) as being unpatentable over **Rostoker** in view of **Gnade**.

Regarding claim 108, the prior art of **Rostoker**, as explained above, discloses each of the claimed features except for indicating that spun-on liquid mass is cured.

Gnade teaches a liquid, spin-on, matrix forming material of TEOS (as above), which is converted, at least in part, to SiO₂ by curing to form a porous dielectric layer between conductive metal lines (like **Rostoker**), wherein the liquid TEOS is dissolved in two solvents, ethanol and water, and wherein ethanol has a higher vapor pressure than water, (as further limited by instant claim 109). The spun-on liquid is converted to SiO₂ by curing (col. 4, lines 64-67), and the solvents are removed by evaporation (col. 5, lines 13-16), as further limited by instant claim 110.

It would have been obvious for one of ordinary skill in the art, at the time of the invention to apply the curing method and solvents of the **Gnade** method to the **Rostoker** method because (1) **Rostoker** applies a liquid which must be cured in order to form a self-supporting dielectric layer 24 (i.e. the mass); (2) **Gnade** teaches a liquid spin-on SiO₂ matrix which is the preferred material for the matrix in **Rostoker**; and (3) **Rostoker** is silent to the steps following the curing of the liquid which would motivate one of ordinary skill to find out what curing steps are required, such as those taught in **Gnade**, for a similar purpose.

Regarding claim 111, Rostoker does not teach “forming a layer over the mass **before** partially vaporizing” (emphasis added). Gnade teaches this feature, as noted above. It would have been obvious for one of ordinary skill in the art, at the time of the invention to modify Rostoker in view of Gnade to partially vaporize after forming the layer over the mass because it appears that forming the layer over the mass before vaporizing would work just as well as forming it after vaporizing, as is also clear in the instant invention. Further the selection of any order of performing process steps is prima facie obvious in the absence of new or unexpected results. (See MPEP 2144.04.) In the instant case, the same result is obtained in Gnade and Rostoker, i.e. a porous dielectric layer with a layer overlying the porous layer whether the layer is formed before or after the vaporization step.

6. Claim 114 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Rostoker** in view of either of **Matthews** (US 5,171,713) and **TeVelde** (US 4,561,173).

Neither **Rostoker** does not teach support member between the pair of conductive metal lines.

Each of **Matthews** (US 5,171,713; Fig. 23B, 26B, pedestal **102** between conductive features **98** and **99**) and **TeVelde** (US 4,561,173; col. 5, lines 16-26; cover Fig., item **12** between conductive features **3-5**, **10**) teach support structures used in air gaps to provide the needed support between metallization structures. It would have been obvious to apply either of **Matthews** and **TeVelde**, to the invention of **Rostoker**, to provide necessary support where support is needed, as between metallization structures which are not close enough together to provide the needed support.

Note in pertinent part that **Rostoker** indicates that the dielectric layer may be fragile and therefore in need of support due to the presence of overlying layers. (See also col. 5, lines 25-39.) One of ordinary skill would be motivated to use the support structures, additionally, because the dielectric in **Rostoker** could be made of even lower dielectric constant by incorporating even more pores. Such increase in pores, while lowering the dielectric constant, would also make the porous dielectric layer more fragile and consequently in need of such support members, but would also desirably result in reducing, further, the RC delay.

Should Applicant think that **Matthews** and **TeVelde** are not appropriate for the instant invention because of the method used to form the "support structures." Applicant is referred to the instant specification, page 14, lines 5-6, wherein it is stated, "Support members 38 can be formed by methods **readily apparent to persons of ordinary skill in the art.**" (Emphasis added.) Therefore, all that is required of the inventions of either of **Matthews** and **TeVelde** is that they suggest the use of such support structure. Applicant has already admitted that the methods of forming the support members are known to those of ordinary skill.

Allowable Subject Matter

7. Claims 100 and 101 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

8. The following is a statement of reasons for the indication of allowable subject matter: Regarding claim 100, although each of **Cho** and **Gnade** teach the use of two solvents (ethanol and water) that meet the claimed limitation of having different volatilities, the prior art does not

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teach or fairly suggest, in combination with the other claimed limitations, that the more volatile solvent is removed during partial curing, while the other solvent removed during evaporation of the mass. Instead, **Cho** and **Gnade** carry out solvent exchange and remove the final solvent in the chain by evaporation (i.e. drying).

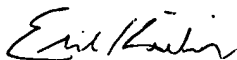
Regarding claim 101, this claim is only considered to have allowable subject matter because it depends from claim 100. The limitation of substantially totally vaporizing the mass is indicated by Applicant to be known in the art, as shown in prior art Fig. 3. It would have been obvious for one of ordinary skill in the art, at the time of the invention to totally vaporize the mass of either Cho or Gnade, as taught by Applicant, to further reduce the dielectric constant of the dielectric between the conductive features, thereby further reducing RC delay and increasing the device speed, which is of primary importance in the semiconductor device fabrication art.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 703-306-5980. The examiner can normally be reached on 9:00 - 19:30 on Monday through Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached at 703-306-2417. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9318 for regular communications and 703-872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.



Erik Kielin

May 11, 2002